Implications of ending the sale of petrol and diesel vehicles in the UK by 2030

Prepared for WWF

: vivideconomics

Overview

Summary and key messages

Part 1: Impacts of a 2030 phase out on the road transport sector

Part 2: Impacts on the UK automotive sector

Part 3: Implications for environment and energy

Part 4: Implications for the electricity system

Impact on the road transport sector

- A 2030 phase out could increase the number of electric cars and vans from 11 million vehicles to 17 million in 2030.

- The 2030 phase out would increase the scale of charging infrastructure needed in 2030 to around 21 million chargers, relative to around 13 million under the 2040 phase out.
- Home and workplace charging infrastructure will be extensive; long-distance en-route charging, and parking-based charging infrastructure are also important, but much smaller scale.

Impact on the automotive sector

- As a result of a 2030 or a 2040 phase out, the UK could become the dominant EV market in Europe; in a 2030 phase out scenario the UK market is 42% of total European sales.
- This will provide an opportunity for both UK and European EV production; the increase in UK production will depend on its ability to develop and maintain a competitive EV industry.

- 2030 scenario: If UK's share of future EV production evolves in line with its share of conventional vehicles today, it could produce around 800,000 EVs per year (200,000 more than under the 2040 scenario). In this scenario, GVA in the EV industry increases to around £7.3 billion, and jobs in the EV industry to around 86,000 (an additional £1.9 billion of GVA and 24,000 jobs relative to the 2040 scenario).

- 2030+ scenario: If the UK's larger domestic market creates incentives for a larger share of total EV production to be located in the United Kingdom, it could produce an additional 100,000 EVs per year, accounting for a further £1 billion of GVA and 14,000 jobs.

Impact on the environment and energy

- The 2030 phase out would reduce tailpipe CO_2 emissions by 13 $MtCO_2$ in 2030, and 62 $MtCO_2$ over the fifth carbon budget period.
- This saving could reduce the policy gap to meet the fifth carbon budget by 53%.
- Put differently, this is equivalent to the CO_2 from 6 million homes or 16 power stations.

- The 2030 phase out would reduce NO_x emissions by around 14 kilotonnes, and PM_{10} emissions by 210,000 tonnes in 2030.
- The economic value of this reduction could be between £127-485 million per year in 2030.

- The 2030 phase out would reduce oil consumption, and therefore net oil imports, by around 3.6 mtoe in 2030.

Implications for the electricity system

- The 2030 scenario with smart charging is lower cost than the 2040 scenario with standard charging, and therefore cheaper for consumers.
- Smart charging could reduce the costs of charging electric vehicles by 42% in both 2030 and 2040 scenarios.
- A combination of smart charging and V2G could reduce these costs by 49% in the 2040 scenario, and 46% in the 2030 scenario.
- Running an electric vehicle could add around £175 per year to the vehicle owner's electricity bill under standard charging, and smart charging and/or V2G could similarly reduce this expenditure by nearly half. This compares to an average of over £800 to run a new petrol or diesel car or van today.
- For repurposing to have a material value, innovations are needed to achieve a minimum lifetime and maximum repurposing cost. With such innovations, the total potential value of these batteries in the 2040 scenario could be around £250 million in 2040 and £1 billion in 2050. In the 2030 scenario, it could increase to around £400 million in 2040 and £1.3 billion in 2050.

Overview of scenarios

Scenario	Current	2040	2030	2030+
Year	2017	2030		
Electric vehicles	137,000	13 million	20 million	
GVA in UK automotive manufacturing	£13 billion	£14 billion	£14 billion	£16.5 billion
Jobs in UK automotive manufacturing	137,000	147,000	144,000	180,000
CO_2 emissions	89 $MtCO_2$ (2016)	50 $MtCO_2$	38 $MtCO_2$	
NO_2 emissions	182 kt (2015)	56 kt	42 kt	
PM_{10} emissions	3.2 kt (2015)	0.9 kt	0.7 kt	

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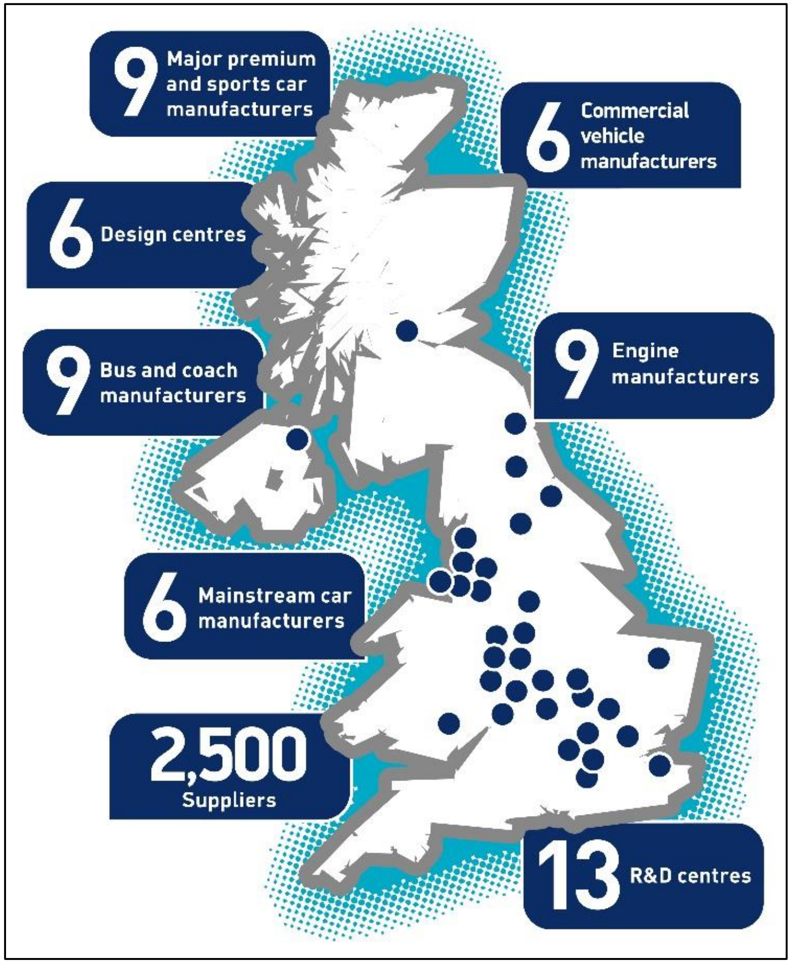
Key facts about UK automotive

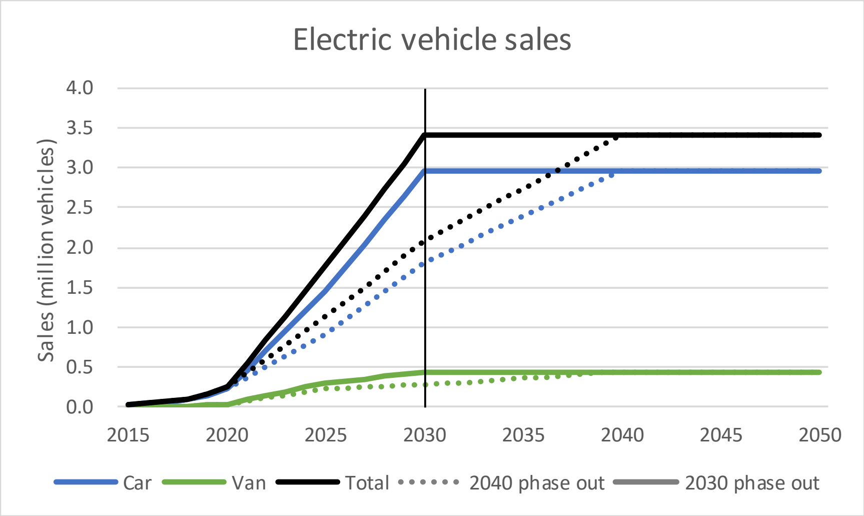
- 6 volume manufacturers: Jaguar-Land Rover (500k), Nissan (500k), MINI (200k), Toyota (200k), Honda (100k), Vauxhall (100k). 4th largest in Europe.
- 1.7 million cars manufactured, and rising, of which 1.35 million are exported.
- 88% cars consumed are imported, although 3 of the top 10 sold models (Nissan Qashqai, Vauxhall and MINI) made here.
- Over 37%* of cars in UK production are premium vehicles.
- A comparative advantage in car manufacture but relative weakness in parts, with 42% of UK made components in UK made cars, compared to 60%** in Germany and France.
  - Notable exception is ICE engines.

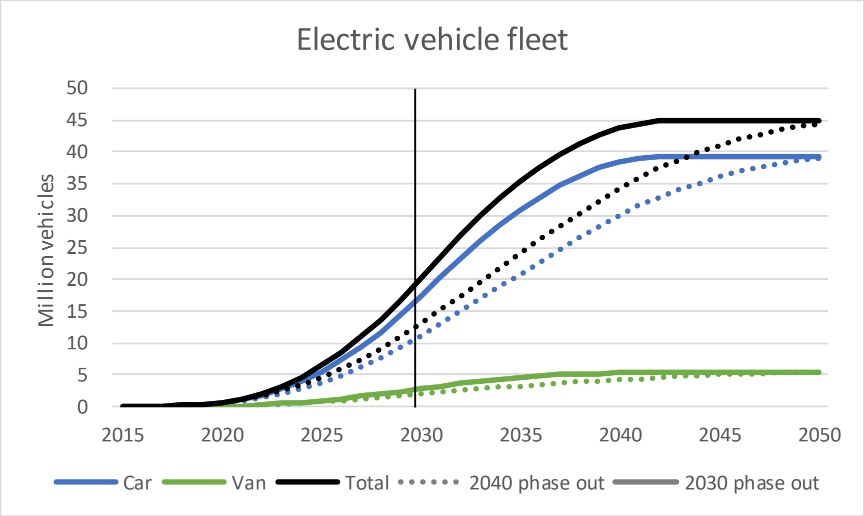


* 2010 estimate, likely to have increased since
** Based on anecdotal evidence as published by the Automotive Council

Source: SMMT

A 2030 phase out could increase electric vehicles to around 20 million in 2030, from 13 million under a 2040 phase out

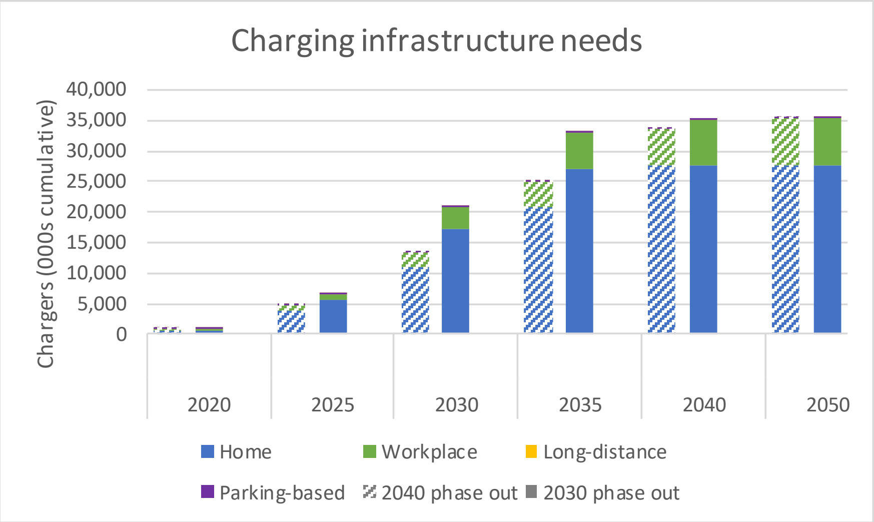


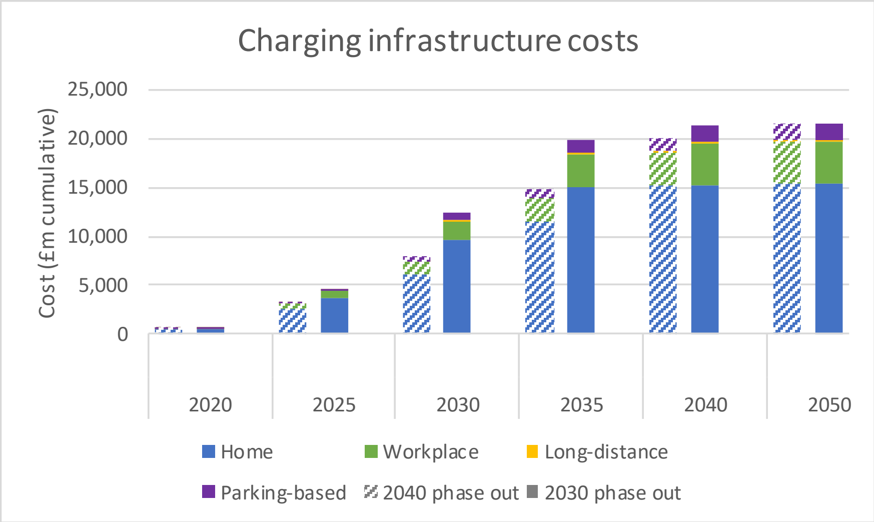


Sales (million vehicles)							
Phase out		2020	2025	2030	2035	2040	2050
2040	Car	0.2	0.9	1.8	2.4	3.0	3.0
	Van	0.0	0.2	0.3	0.4	0.4	0.4
2030	Car	0.2	1.5	3.0	3.0	3.0	3.0
	Van	0.0	0.3	0.4	0.4	0.4	0.4

Fleet (million vehicles)							
Phase out		2020	2025	2030	2035	2040	2050
2040	Car	0.6	3.8	11.1	20.8	30.0	39.0
	Van	0.1	0.7	1.9	3.2	4.2	5.4
2030	Car	0.6	5.5	17.3	30.8	38.4	39.4
	Van	0.1	1.0	2.8	4.6	5.3	5.4

Home and workplace charging infrastructure will be extensive; long-distance and parking-based infrastructure will be smaller scale





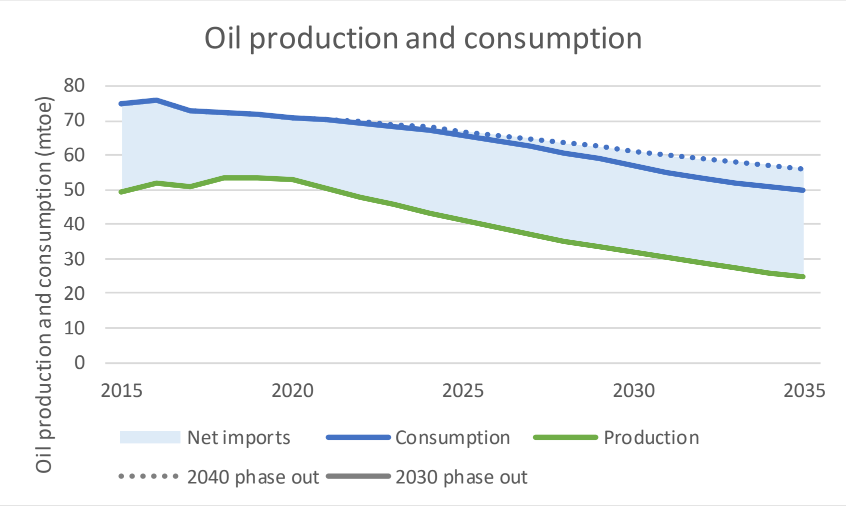
Chargers (000s, cumulative)							
Charging	**Phase out**	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
Home	2040	600	4,000	11,000	21,000	28,000	28,000
	2030	600	5,000	17,000	27,000	28,000	28,000
Workplace	2040	100	800	2,000	4,000	6,000	8,000
	2030	100	1,000	3,000	6,000	8,000	8,000
Long-distance	2040	1	1	1	2	3	4
	2030	1	1	2	3	4	4
Parking-based	2040	6	10	30	50	70	100
	2030	6	20	40	70	90	90
Total	**2040**	**700**	**5,000**	**13,000**	**25,000**	**34,000**	**35,000**
	2030	**700**	**7,000**	**21,000**	**33,000**	**35,000**	**36,000**

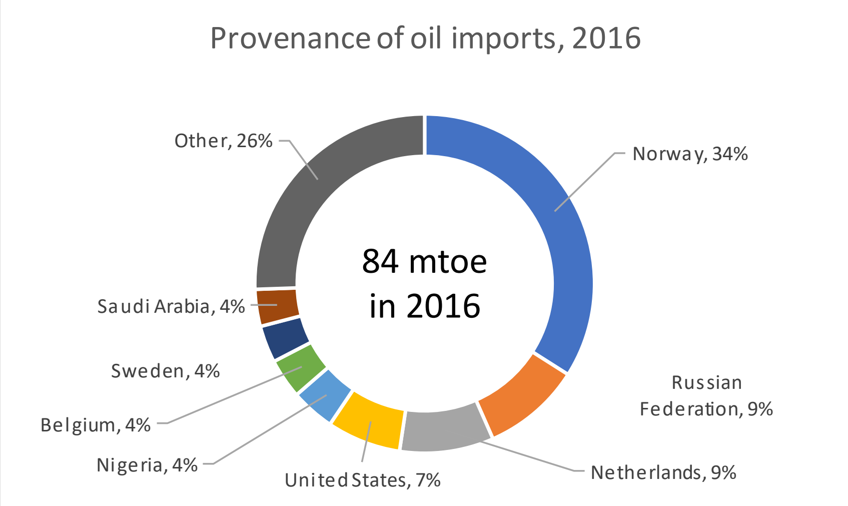
Chargers (000s, cumulative)							
Charging	**Phase out**	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
Home	2040	500	3,000	6,000	12,000	15,000	15,000
	2030	500	4,000	10,000	15,000	15,000	15,000
Workplace	2040	90	500	1,000	2,000	3,000	4,000
	2030	90	700	2,000	3,000	4,000	4,000
Long-distance	2040	16.7	23.6	30.0	56.3	81.3	105.8
	2030	16.7	33.2	46.4	82.4	102.7	105.2
Parking-based	2040	16.7	23.6	500.0	937.7	######	######
	2030	16.7	33.2	772.5	######	######	######
Total	**2040**	**600**	**3,000**	**8,000**	**15,000**	**20,000**	**22,000**
	2030	**600**	**4,000**	**12,000**	**20,000**	**21,000**	**22,000**

2030 vehicles and chargers by nation

		Total	England	Scotland	Wales	Northern Ireland
Sales (million vehicles)	Car	3.0	2.6	0.2	0.1	0.1
	Van	0.4	0.4	0.0	0.0	0.0
Fleet (million vehicles)	Car	17.3	15.0	1.2	0.8	0.4
	Van	2.8	2.4	0.2	0.1	0.1
Charge points (thousand chargers)	Home	17344	14975.1	1164.3	762.8	441.6
	Workplace	3469	2995.0	232.9	152.6	88.3
	Long-distance	2	1.6	0.1	0.1	0.0
	Parking-based	42	36.0	2.8	1.8	1.1

A 2030 phase out would reduce oil demand by around by around 4.4 million tonnes of oil equivalent (mtoe), or 15% of net imports in 2030





This could save around £2 billion per year (with a range of £1.4-3.1 billion), depending on oil prices.

Oil and oil products are highly traded; while net imports of oil and oil products to the UK were around 25 mtoe, total imports were 84 mtoe, and total exports around 59 mtoe.

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A 2030 Phase out makes the UK the dominant EV market in Europe, which may impact the size of its automotive industry

ANALYSING THE IMPACT OF UK EV SALES ON UK AUTOMOTIVE PRODUCTION

The complex automotive trade picture across Europe means that an increase in the UK market does not directly imply an increase in UK EV production.

To illustrate the impact of a 2030 Phase out on EV, ICE and parts production, we compare gross value added and jobs in two 2030 scenarios to the modelled outcomes for a 2040 Phase out.

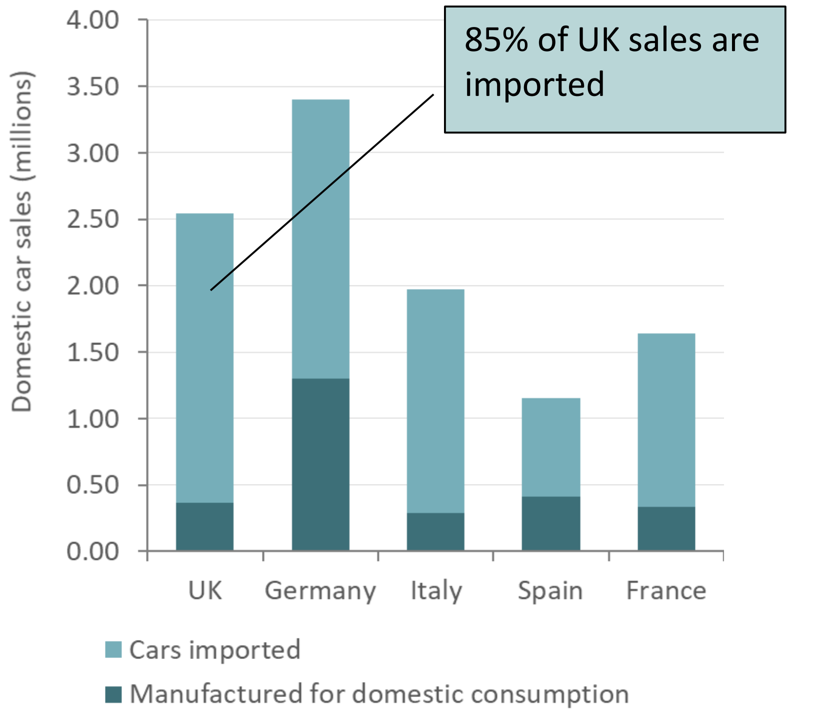
"2030" scenario assumes EV trade patterns will follow existing ICE trade patterns. For example, it assumes the UK will continue to produce 15% of the cars sold in the UK.

"2030+" scenario shows the potential impact of the increased attractiveness as a manufacturing location given its dominant market. This is captured by showing the impact of 1 additional manufacturing plant, and the knock on impacts this has on parts manufacturing in the UK.

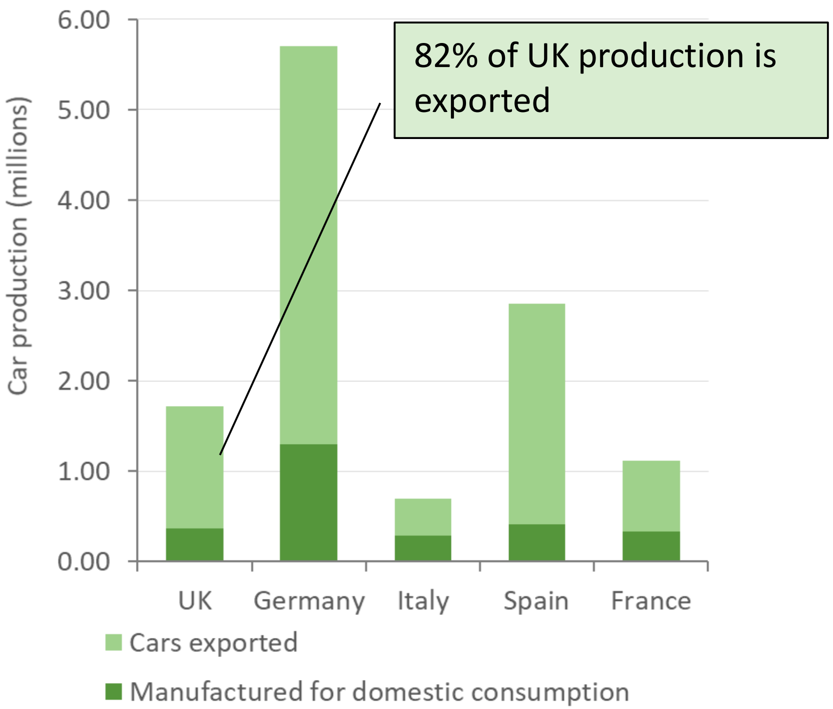
The highly traded European market means that increased UK sales do not translate 1 for 1 into increased UK production

2030 scenario: To reflect that the majority of UK EV sales are likely imported, and the majority of production exported, the "2030" scenario assumes the future UK share of its own and the EU market stays the same as its current share of the ICE markets.

Domestic car sales per country



Car production per country

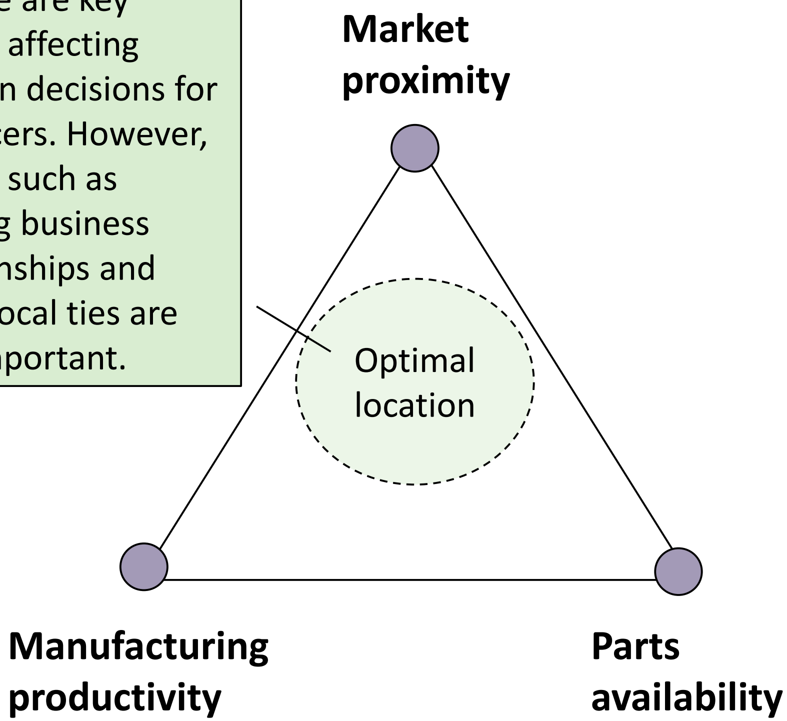


Note: import and export car numbers for France are estimated based on average car cost and trade value

However, market proximity is one of the key factors determining the attractiveness of the UK as an EV production site

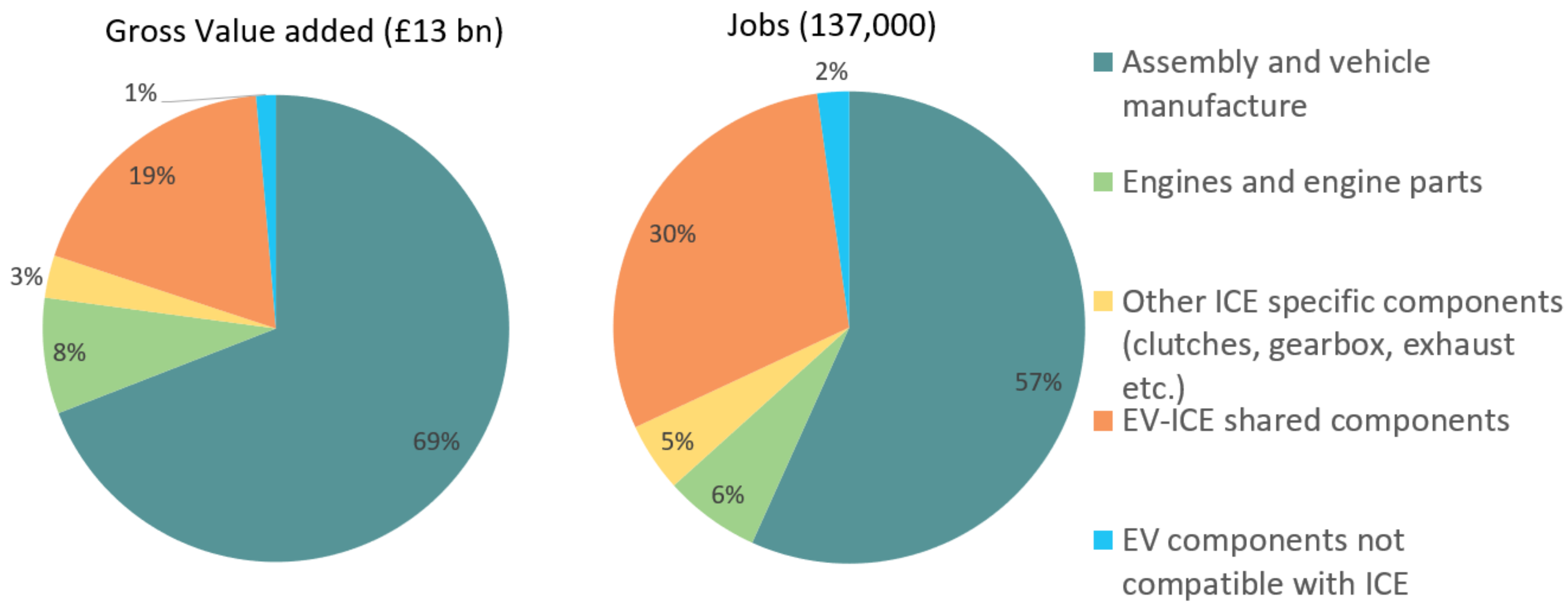
Ingredients for car manufacturing attractiveness

The corners of the triangle are key factors affecting location decisions for producers. However, factors such as existing business relationships and other local ties are also important.



- **Market proximity** reduces transport costs of produces vehicles and, all else equal, producers will optimise their location to be closest to their major demand centres.
- **Parts availability** is an important factor in location decisions. EU parts are highly traded, but any location must have access to established supply chains to be competitive.
- **Manufacturing productivity** is key for location decisions. It largely depends on labour productivity, tax regimes and a variety of other factors such as the cost of ancillary services etc.

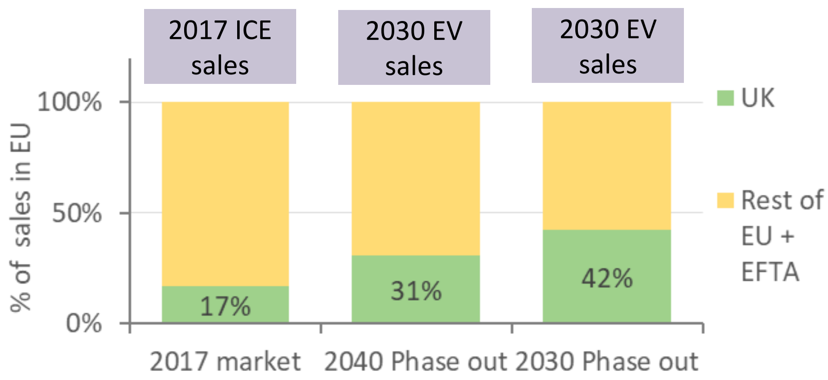
The UK industry is focussed on assembly rather than parts



The UK is likely to become more attractive for EV production than it already is to ICE producers

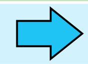
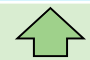
2030+ scenario: To reflect the increased UK attractiveness to EV production, the UK is modelled to attract additional (to the 2030 scenario) production equivalent to a medium size assembly plant, including associated parts production.

1 UK EV sales more dominant than current ICE sales



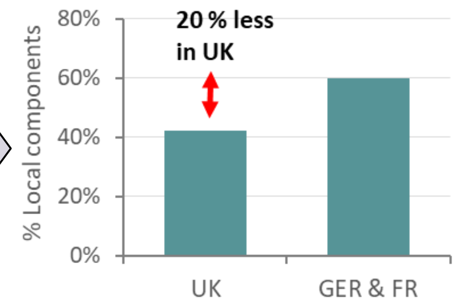
2 Little difference in productivity across EU

	US	FR	GER	IT	NL	UK
Average rank across 9 categories affecting automotive productivity	3.6	2.8	3.3	3.7	3.6	3.6

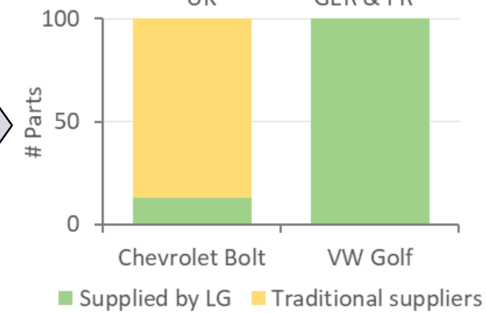
Category	2030 EV compared to current ICE
Proximity to demand	
Manufacturing productivity	
Parts availability	

3 Current UK disadvantage in parts less important for EVs

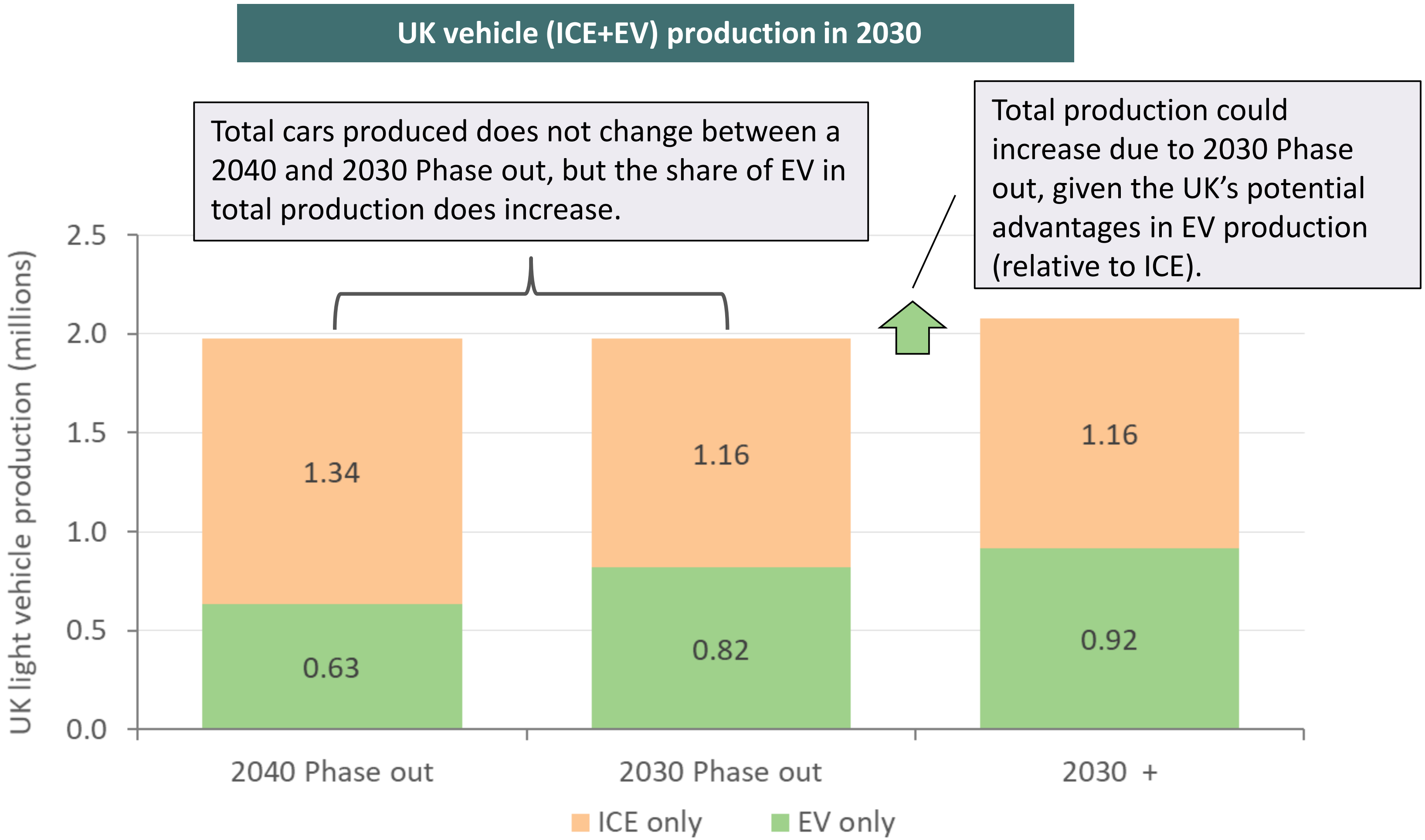
The UK currently produces fewer ICE powertrain parts than Germany and France, thus losing some assembly to those countries.



EV assembly drives a shift away from ICE powertrain parts, and a more level playing field in vehicle assembly.

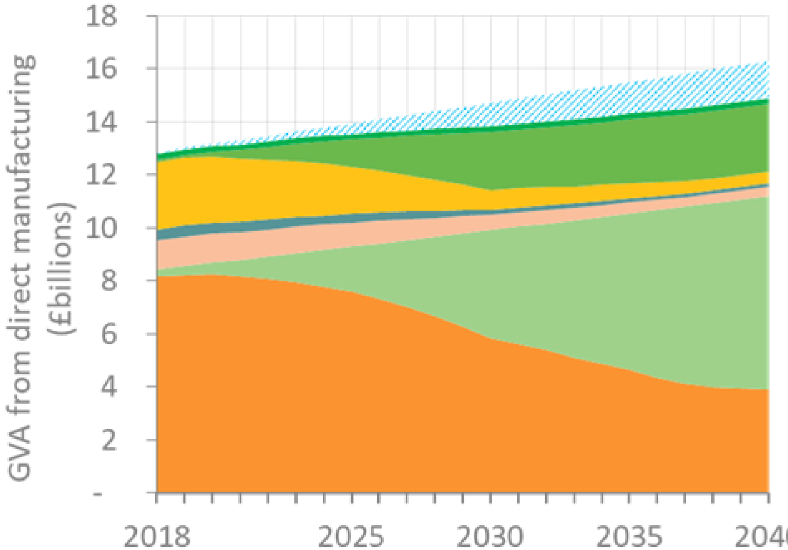


A change in the phase out date change the proportion of ICE and EV production in the UK, and may encourage growth

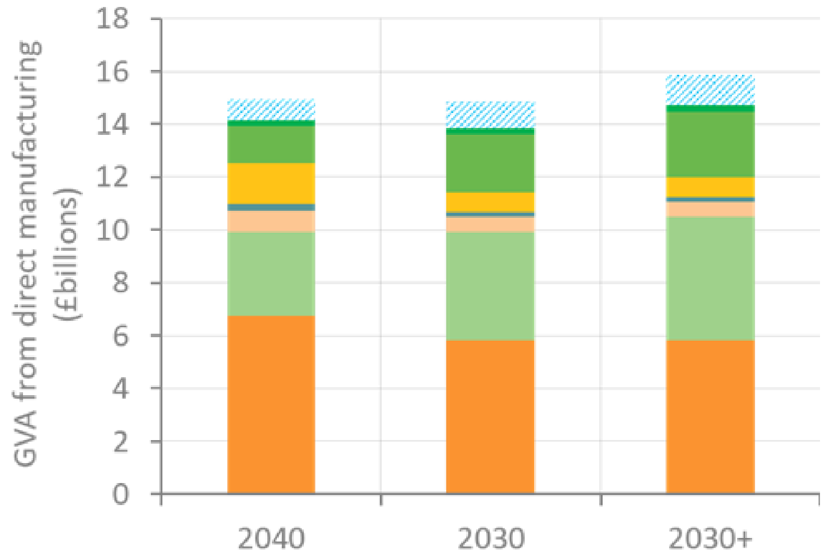


The 2030 Phase out would significantly increase EV related GVA, and leave total automotive GVA nearly constant

2030 Phase out



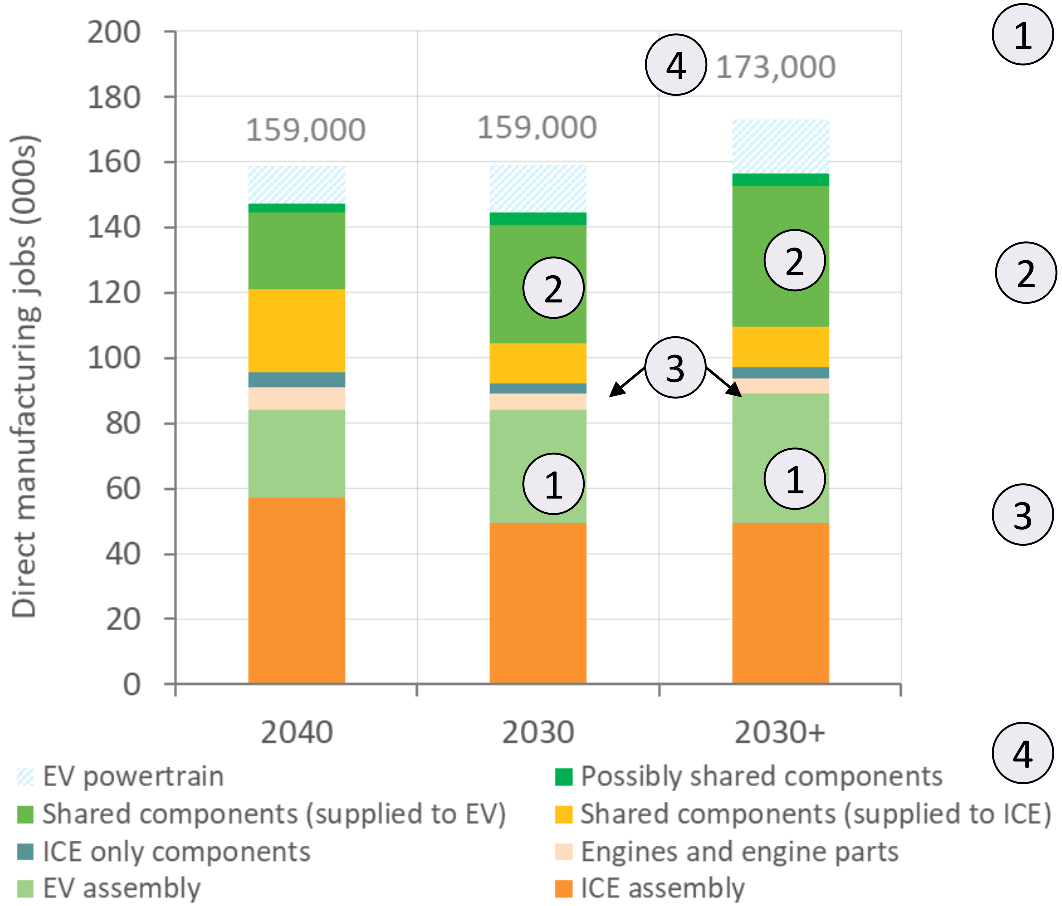
Scenario comparison (in 2030)



EV powertrain
Shared Components (supplied to ICE)
EV assembly
Possibly shared components
ICE only components
ICE assembly
Shared Components (supplied to EV)
Engines and engine parts

A 2030 phase out will bring forward a shift from ICE to EV jobs compared to a 2040 phase out, and could add further jobs

Scenario comparison (in 2030)

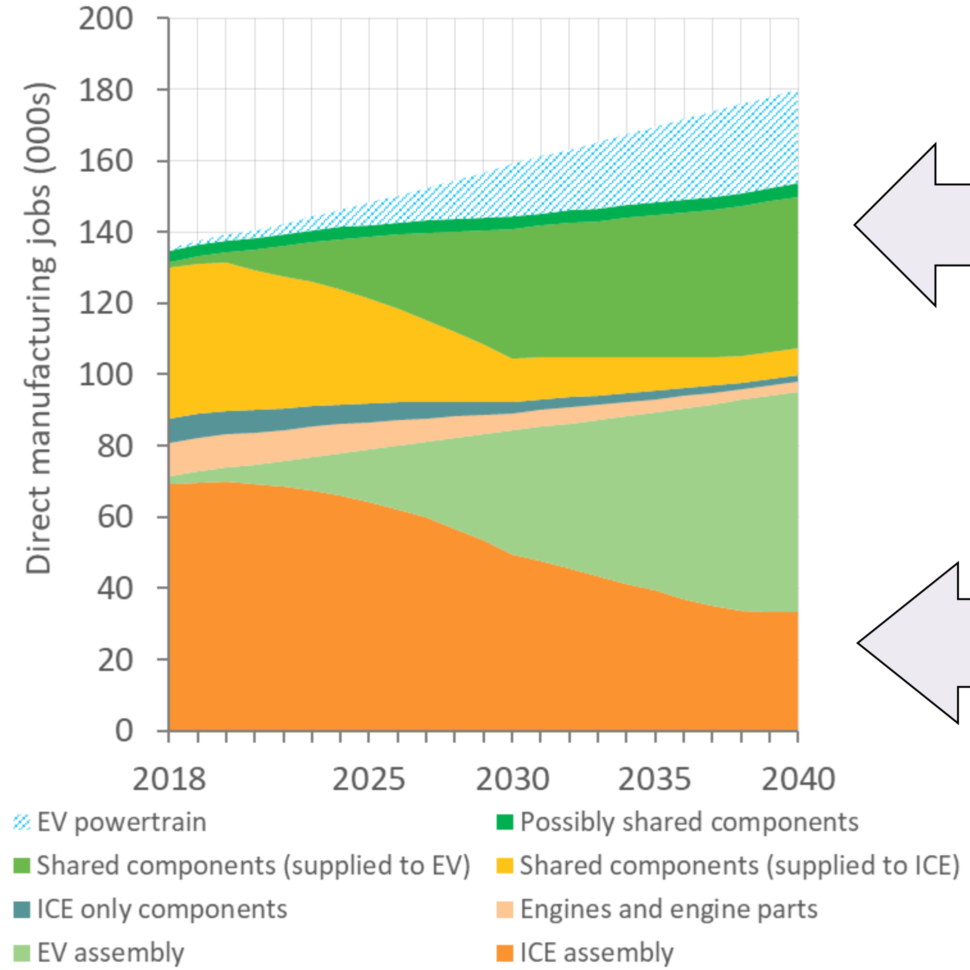


Difference between a 2040 and 2030 Phase out

1. EV assembly jobs increase by 8,000 in a 2030 Phase out, replacing ICE jobs and a further 5,000 are added in the 2030+ scenario.
2. EV parts (compatible with both EVs and ICEs) show a large increase in jobs of 12,000 in the 2030 scenario and a further 7,000 in 2030+.
3. Engine and other ICE only manufacturing jobs decrease by 2,000 and 1,500 respectively compared to the 2040 Phase out.
4. Although speculative, an additional 14,000 jobs may be supported through EV powertrain and charging point manufacture.

Most automotive jobs are likely to shift relatively smoothly from ICE to EV, without being lost

Jobs in a 2030 Phase out



Scenario comparison (in 2030)

Approximately a third of jobs are in components shared by both EVs and ICEs, such as suspension and vehicle bodies. Production of such parts will continue, requiring minimal change adaptation by the workforce.

Approximately half of jobs are in assembly. The skills for EV and ICE assembly are likely to stay relatively constant – with the shift likely comparable to regular training provided when ICE model changes are made. Hence, lost ICE assembly jobs are likely to shift relatively smoothly into EV assembly jobs.

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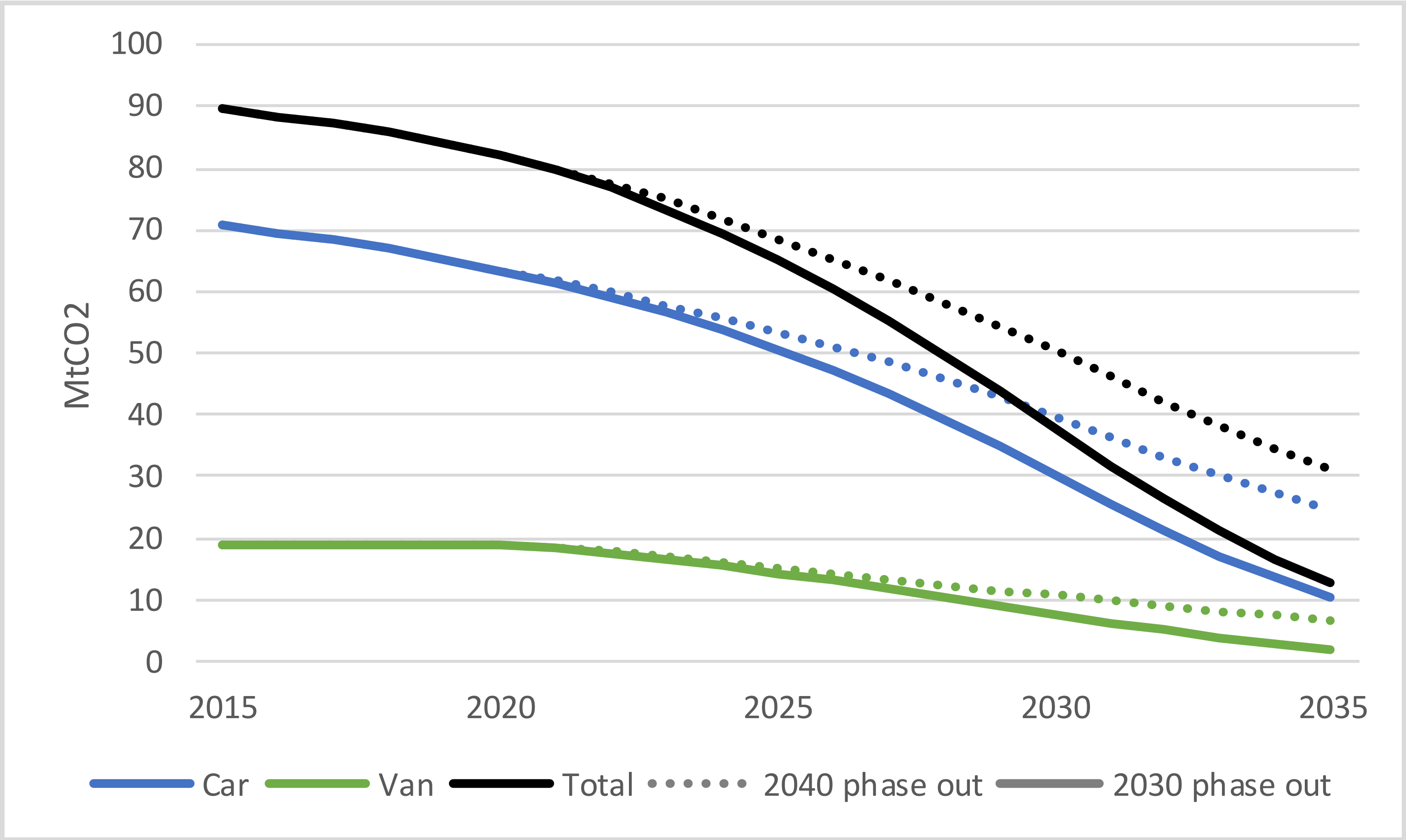
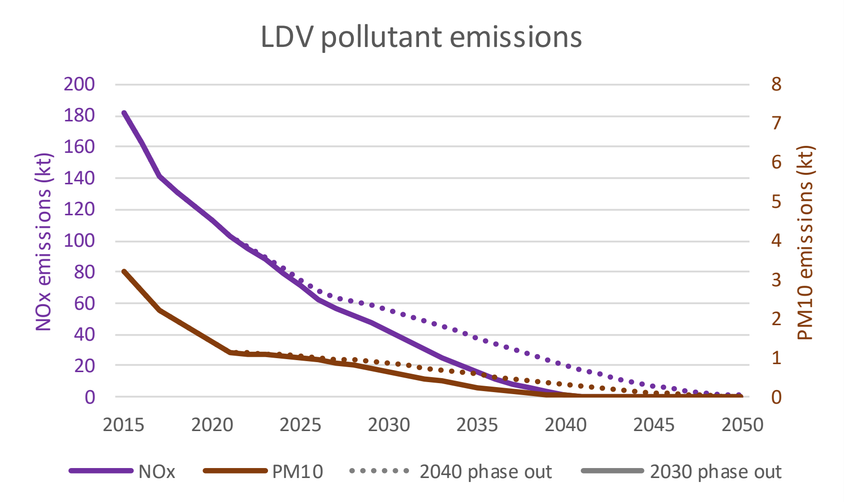
A 2030 phase out would reduce CO_2 emissions by 62 $MtCO_2$ 2028-32, around 53% of the projected Fifth Carbon Budget exceedance



It would also reduce NO_x emissions, delivering health and wider benefits



Values of change in air quality (£m)

	NO_x	PM_{10}	Total
Central	294.5	12.1	306.6
Low	117.8	9.5	127
High	471.1	13.8	485

Source: HMT Green Book

2030 pollutant reductions

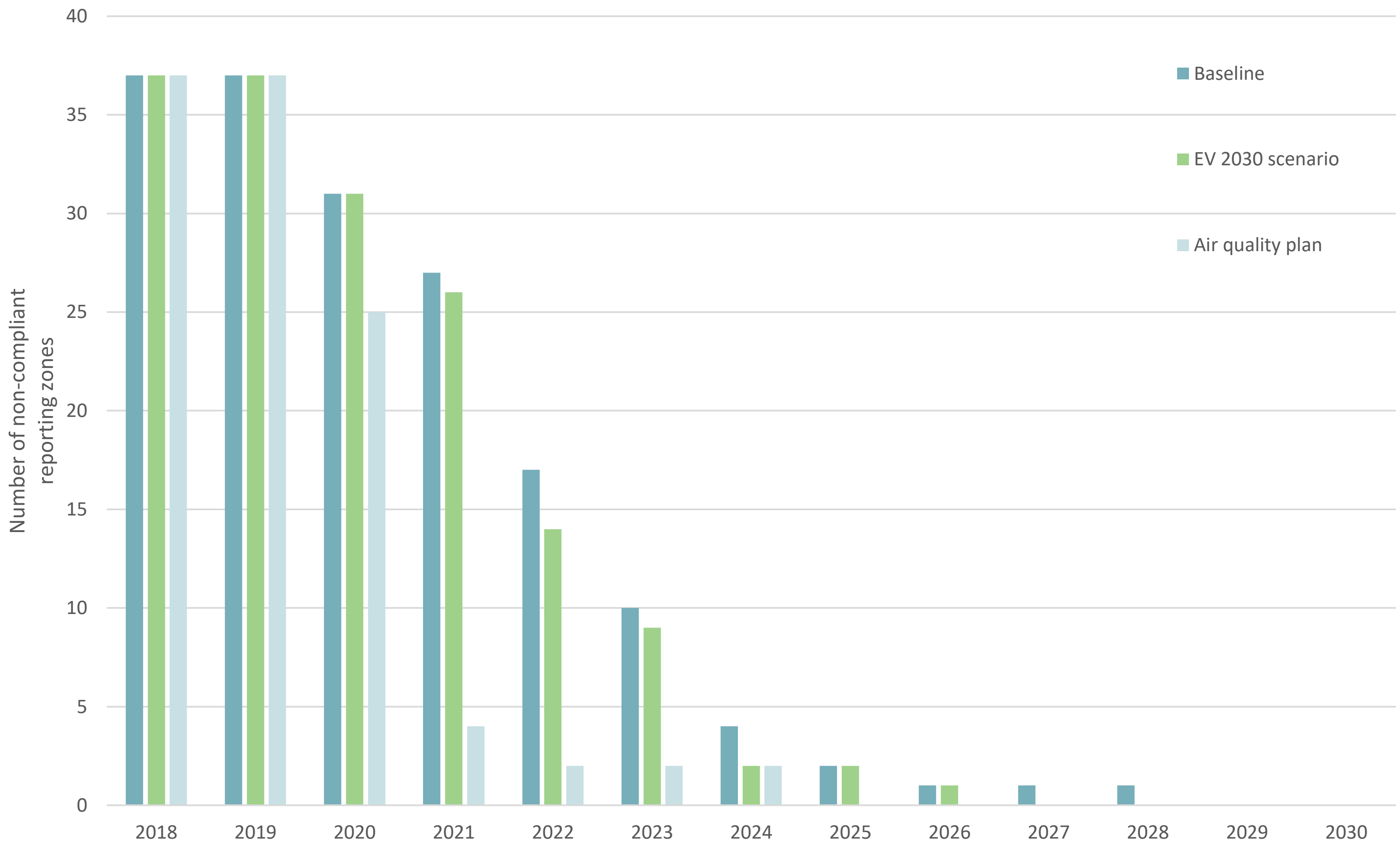
- 14 kt reduction (NO_x);
- 0.2 kt reduction (PM_{10}).

These reductions are valued at £127-485 million, reflecting reduction in disease, healthcare costs and lost productivity.

Policy Exchange estimated that

- the impact of NO_2 concentrations in London failing to improve beyond 2025 at up to 12.2 million life years;
- introducing 220,000 electric vehicles to London could increase average life expectancy by 1.1 million life years.

Impacts of the 2030 phase out on non-compliant reporting zones would be modest



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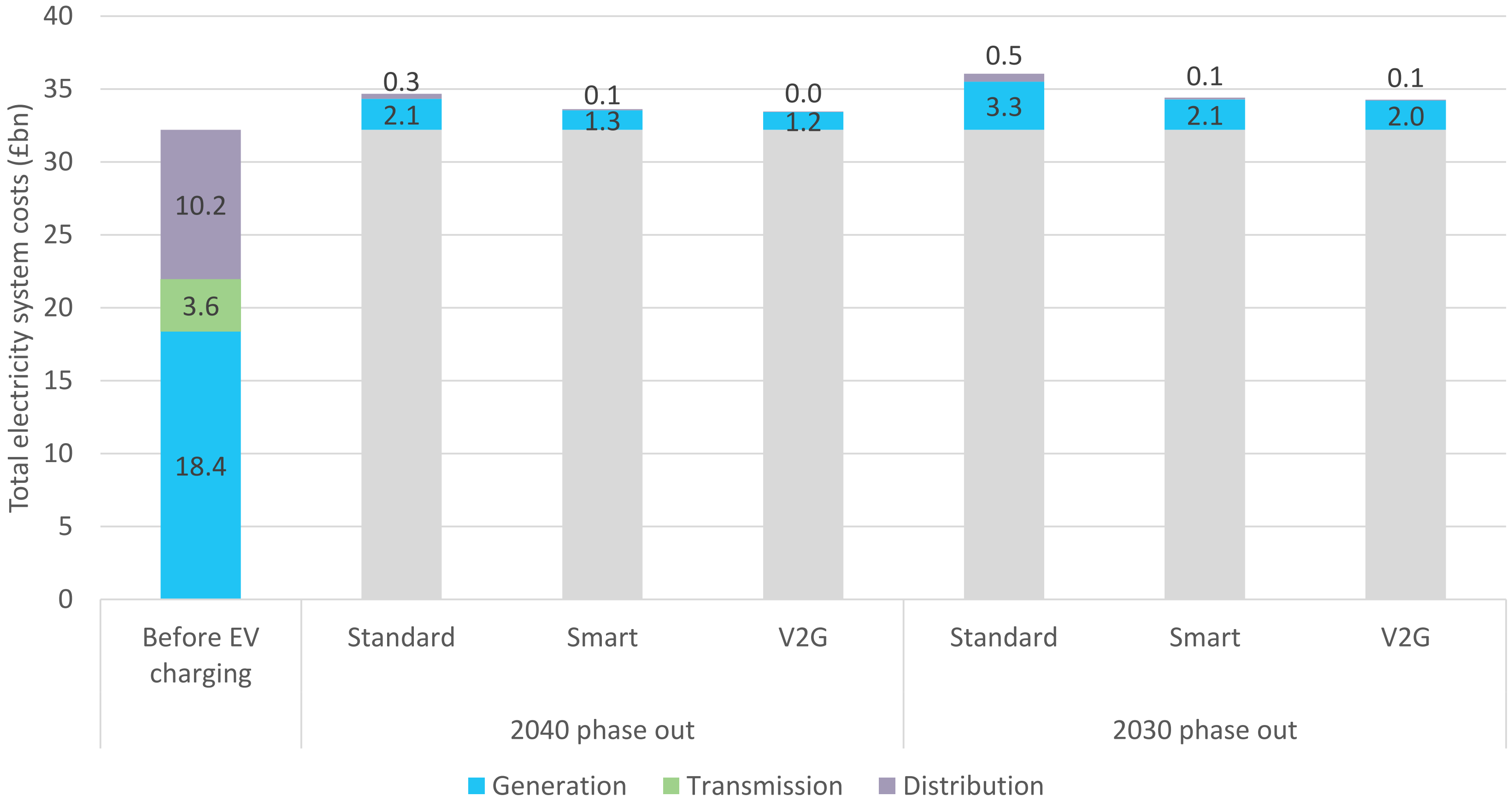
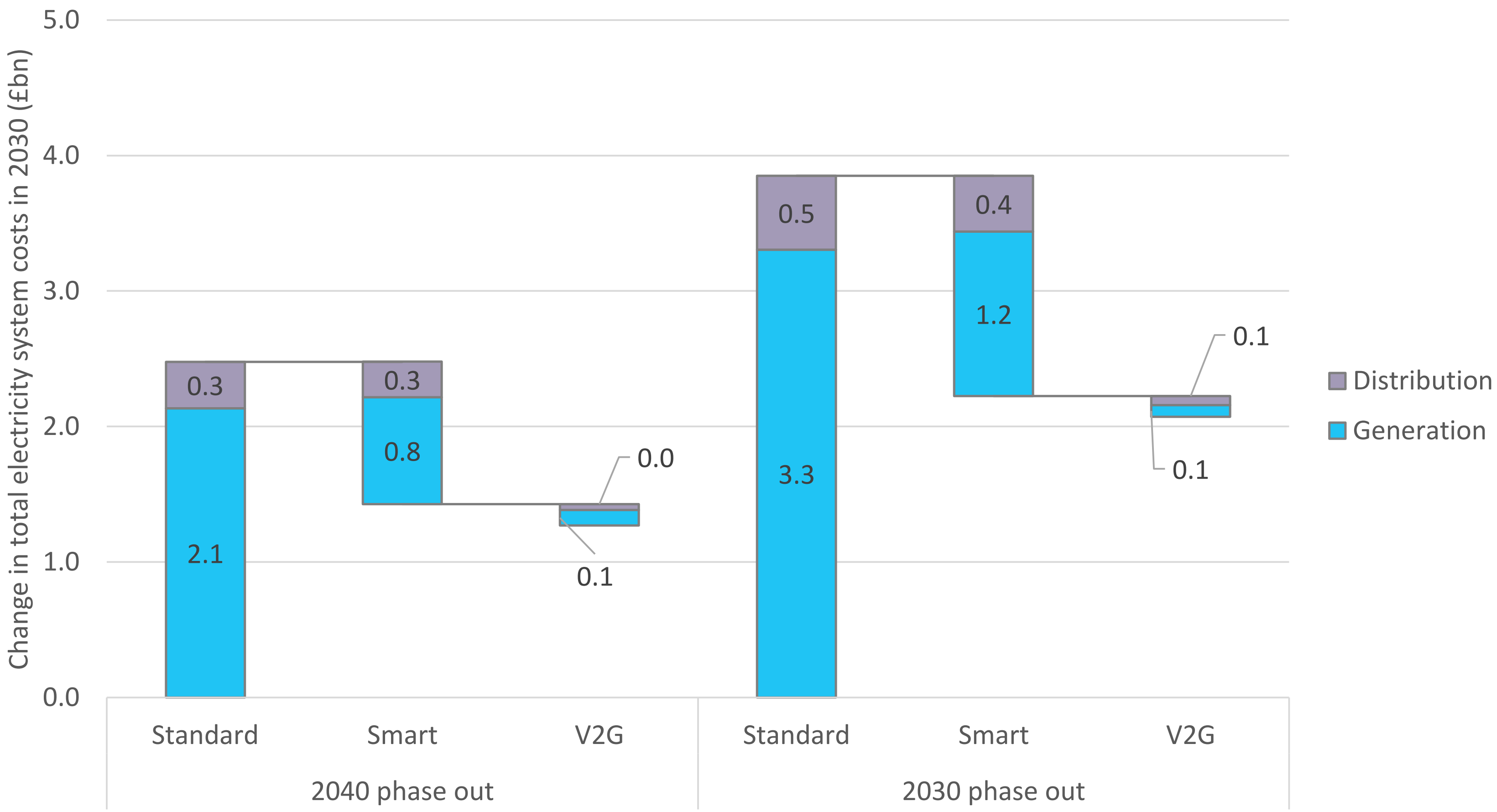
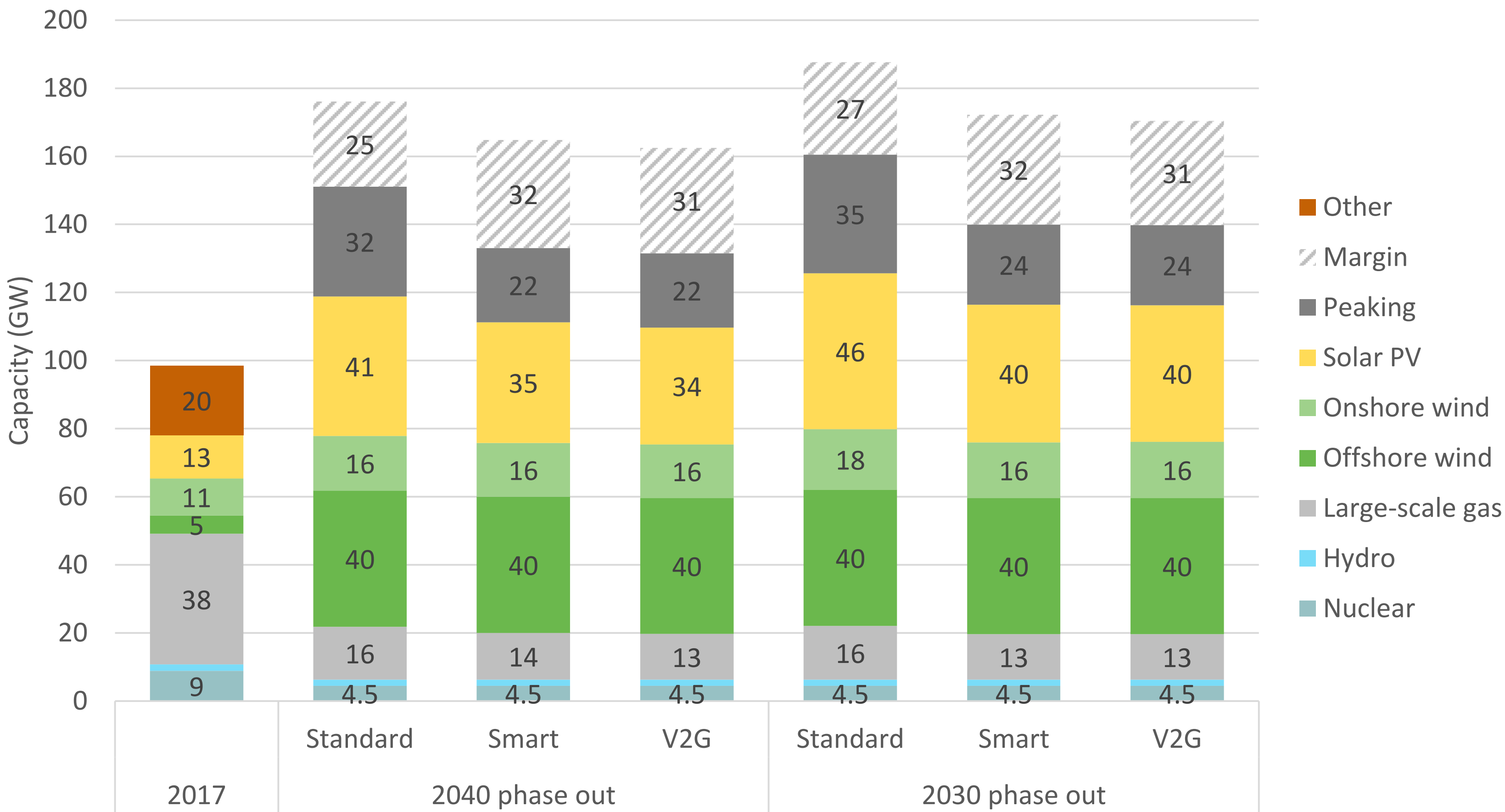
The 2030 scenario with smart charging is cheaper than the 2040 scenario with standard charging (1)



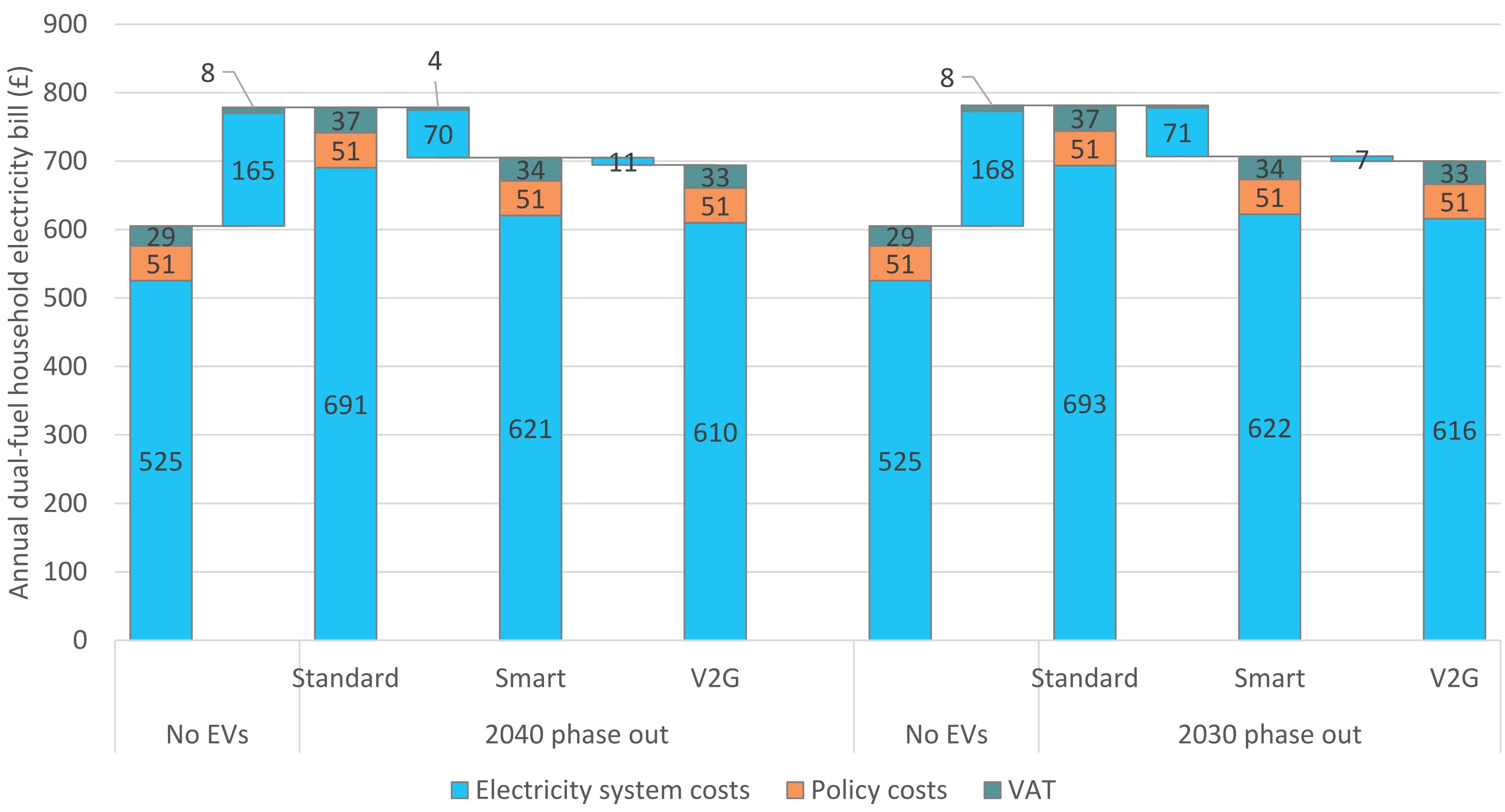
The 2030 scenario with smart charging is cheaper than the 2040 scenario with standard charging (2)



The cost savings from smart charging and vehicle to grid are primarily driven by their impact on the capacity mix



Standard charging could add £175 per year to a driver's electricity bill; smart charging and/or V2G could reduce this by 42-49%.



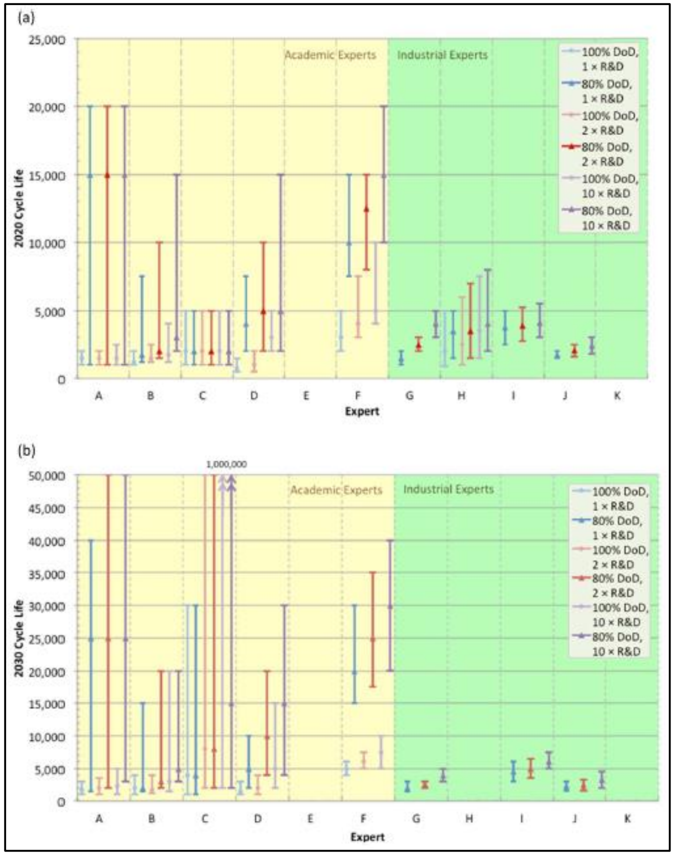
The value of repurposing EV batteries in 2050 could be as high as £1 billion in the 2040 scenario, and higher in the 2030 scenario

- If 50% of electric vehicle batteries can be repurposed and used productively in the electricity system, their value could be £240-400 million in 2040 and £1-1.3 billion in 2050.
- By 2050, this value is around 4% of the total cost of the electricity system, and could reduce total electricity prices and consumer bills by a similar proportion.
- For repurposing to have a material value, innovations are needed to achieve a minimum lifetime and maximum repurposing cost.

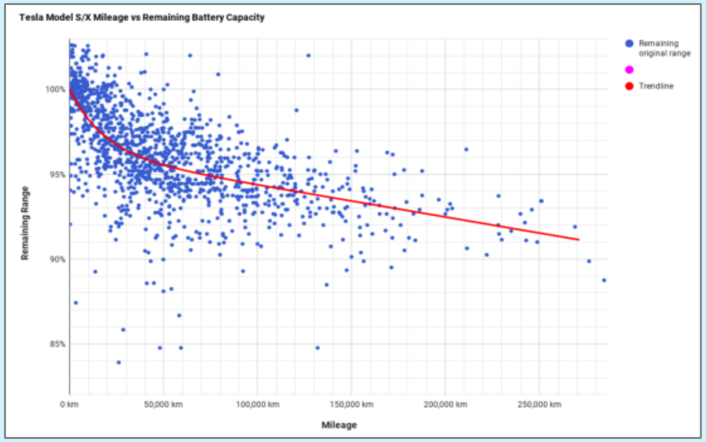
Value of repurposed EV batteries		High need
2040	2040 scenario	£250 million
	2030 scenario	£400 million
2050	2040 scenario	£1 billion
	2030 scenario	£1.3 billion

Battery cycle lives are projected to be adequate for vehicle to grid and subsequent repurposing as stationary storage

- An electric car battery would use around 700 cycles over its lifetime.
- Academic and industry experts estimated a range of lithium ion battery cycle life of 1,500 to 15,000 cycles in 2020.
- This range increases to 2,000 to 30,000 cycles in 2030.



- A real-world trial with Tesla Model S supports the assumption of high cycle life:



- This implies a cycle life of around 3,500 cycles.

- Analysis of the Imperial modelling results suggest 160 cycles per year for a stationary storage battery. If a repurposed battery lasts 10 years this implies an additional 1,600 cycles, or **2,400 in total**.

Few et al. (2018): Prospective improvements in cost and cycle life of off-grid lithium-ion battery packs: An analysis informed by expert elicitations

However, there is significant uncertainty over future calendar life

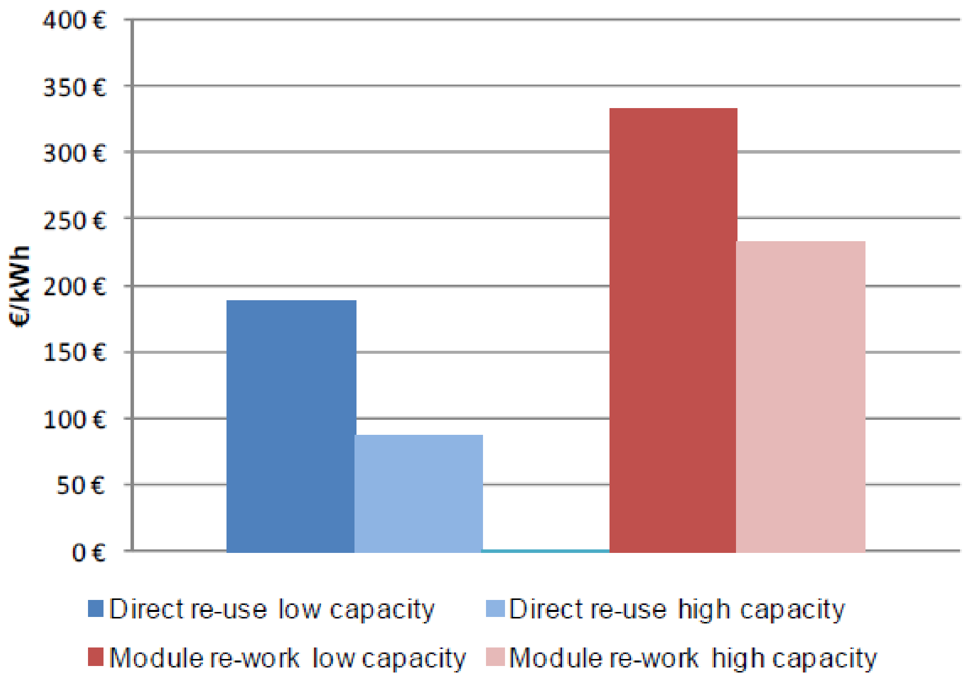
- Nissan provides an 8 year warranty on the LEAF's battery.
- Element Energy (2012) estimated that "based on the expected improvements in thermal control and management, it is reasonable to assume that future cells will achieve a 12 year lifetime (temperate climates) from 2020."
- The United States Advanced Battery Consortium (USABC)[1] have a goal for a calendar life of 15 Years for batteries commercialised in 2020.
- The prospect of a calendar life that significantly exceeds the lifetime of a vehicle is therefore currently **speculative**.
- We assume a calendar life of 23 years: 13 in a vehicle; 10 as stationary storage.

1 Part of United States Council for Automotive Research, comprising Chrysler, Ford, General Motors; collaborative research organisation aiming to strengthen U.S. auto industry technology base

Element Energy (2012): Cost and performance of EV batteries

The costs of repurposing an electric vehicle battery for stationary storage could range from £75-£200/kWh

Cost per kWh of a re-habilitated battery.



Source: Casals et al. (2014): A cost analysis of electric vehicle batteries second life businesses

- Direct re-use: minimal repurposing.
- Module re-work: dismount battery, rearrange cell configurations and repackage for second use.

Repurposing an battery involves

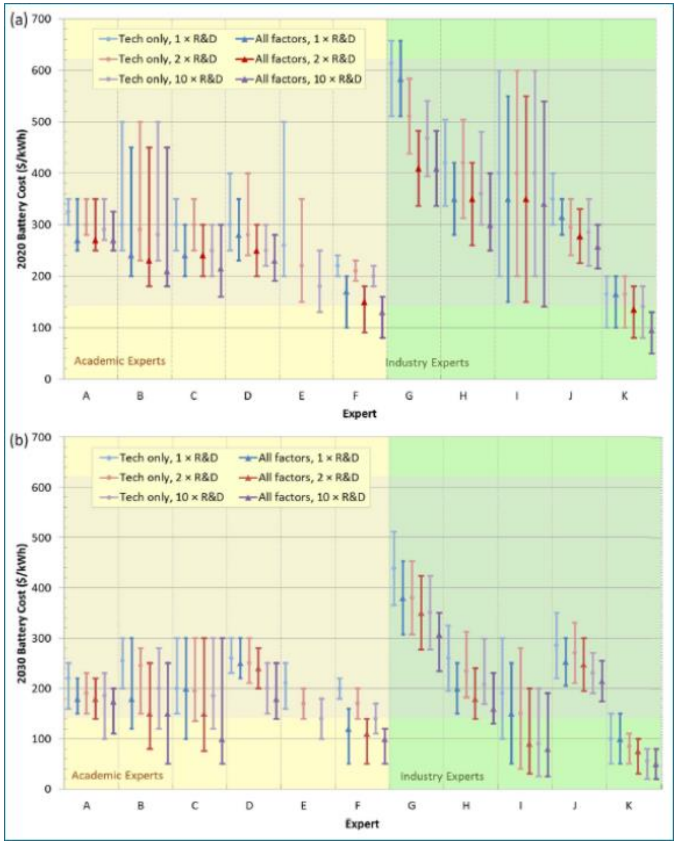
- Dismantling the battery;
- Testing the modules or cells;
- Regrouping the modules or cells for the new application;
- Installation of new refrigeration system and Battery Management System (BMS).

Costs are highly uncertain

- Very few specific studies;
- Typically not linked to specific grid applications.

Repurposed electric vehicle batteries will need to compete with new, dedicated stationary storage batteries on cost

- Academic and industry experts estimated a range of lithium-ion battery costs of $100-$600/kWh in 2020, with an average of $300/kWh (£220).
- This range decreased to $50-$400/kWh in 2030, with an average of $200/kWh (£150).



- Cost projections from the International Renewable Energy Agency (IRENA) suggest that lithium nickel manganese cobalt oxide (the battery chemistry currently used in the Nissan Leaf) could decrease in cost to $145/kWh (£105) in 2030.

- The likelihood that repurposing EV batteries will be cheaper than producing new batteries in 2030 and beyond is uncertain
- Battery cost estimates do not take into account recycling of materials; this blurs the line between repurposing and new batteries.

Few et al. (2018): Prospective improvements in cost and cycle life of off-grid lithium-ion battery packs: An analysis informed by expert elicitations

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Company Profile

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